

FIG.1 (PRIOR ART)

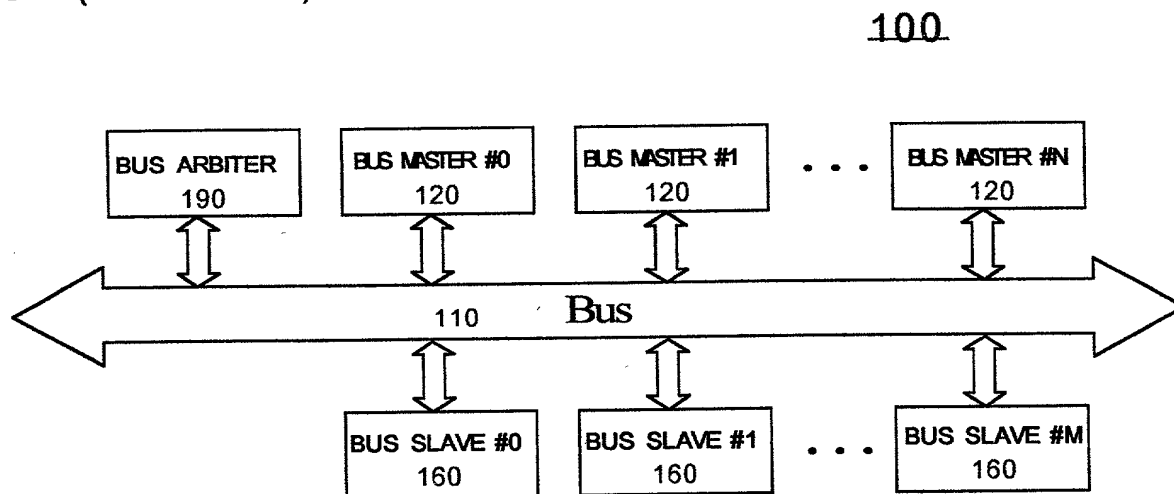


FIG.2 (PRIOR ART)

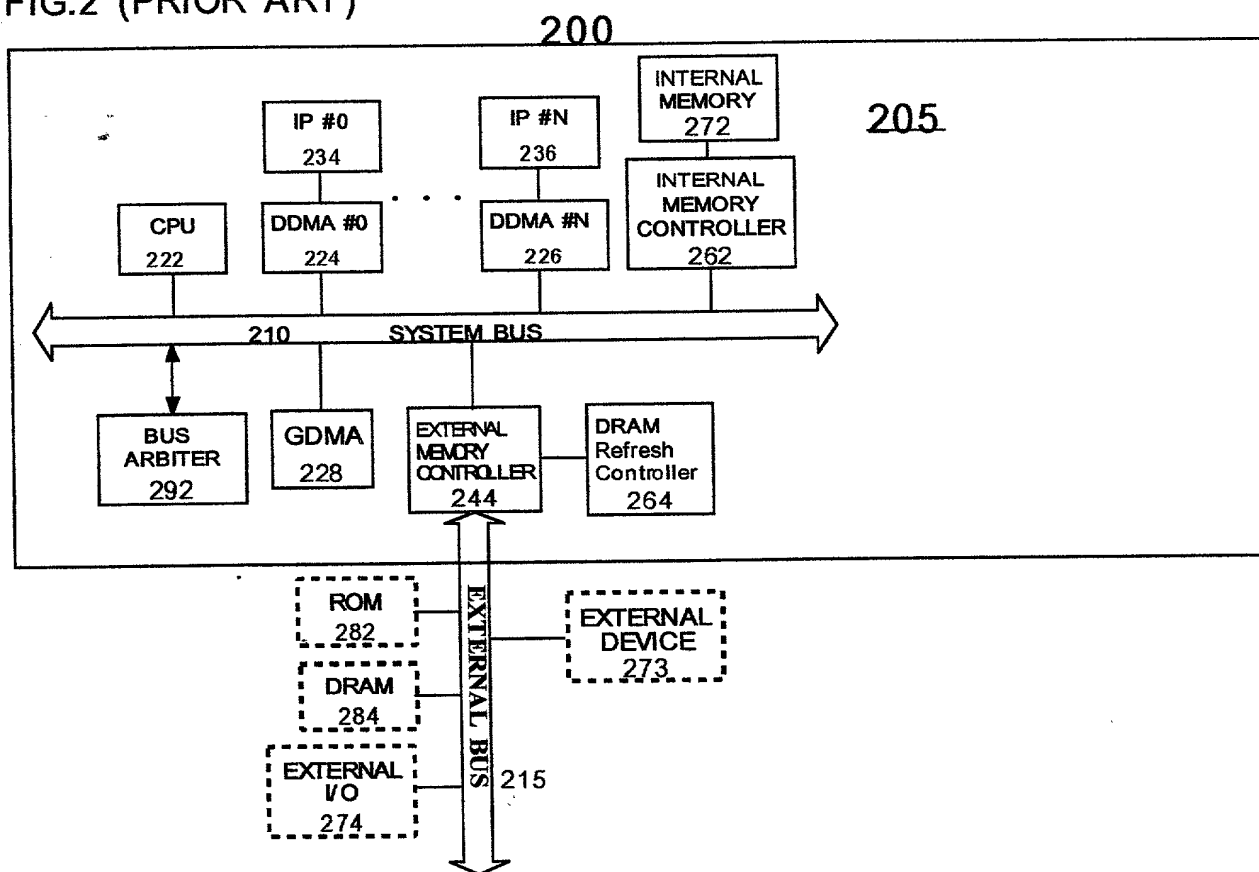


FIG.2B (PRIOR ART)

292

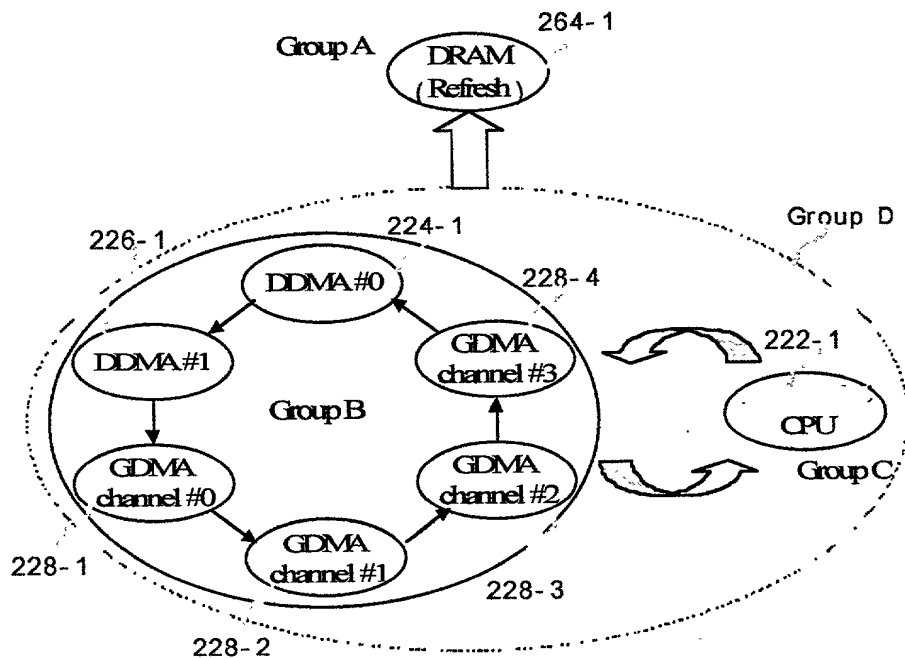


FIG.2C (PRIOR ART)

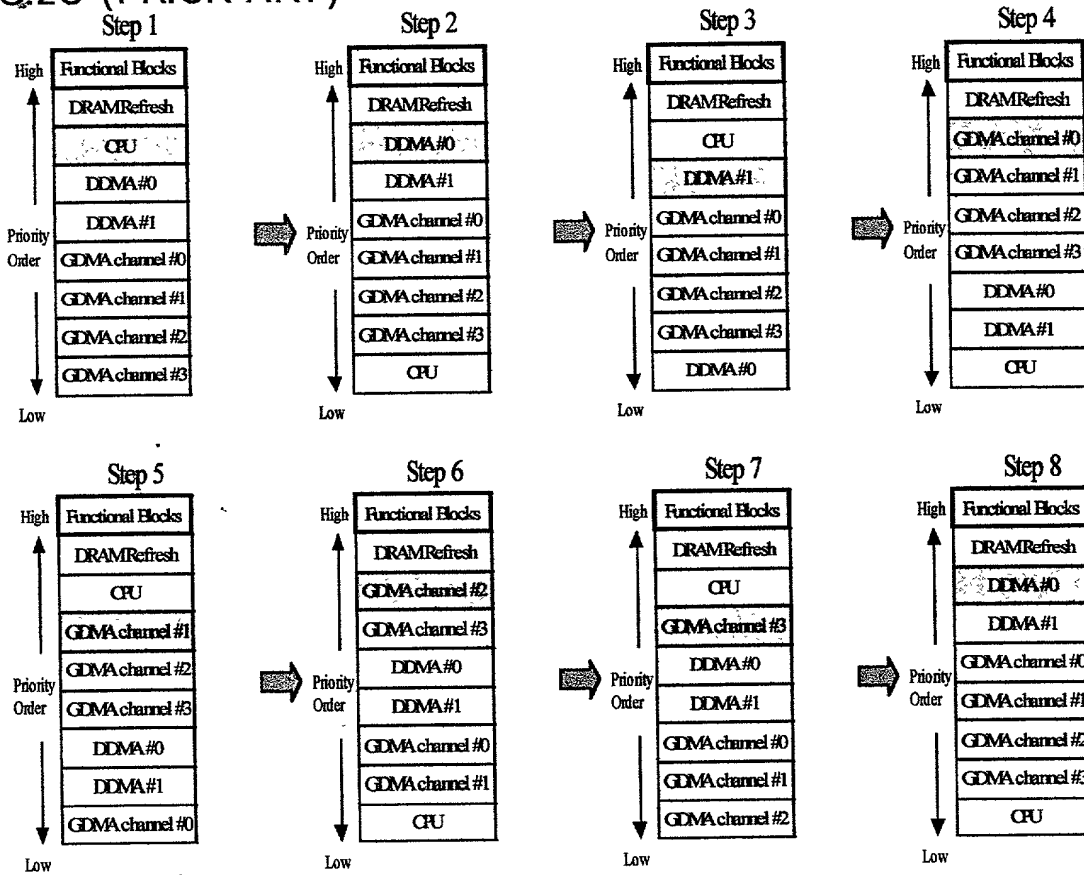


FIG.3A (PRIOR ART)

300

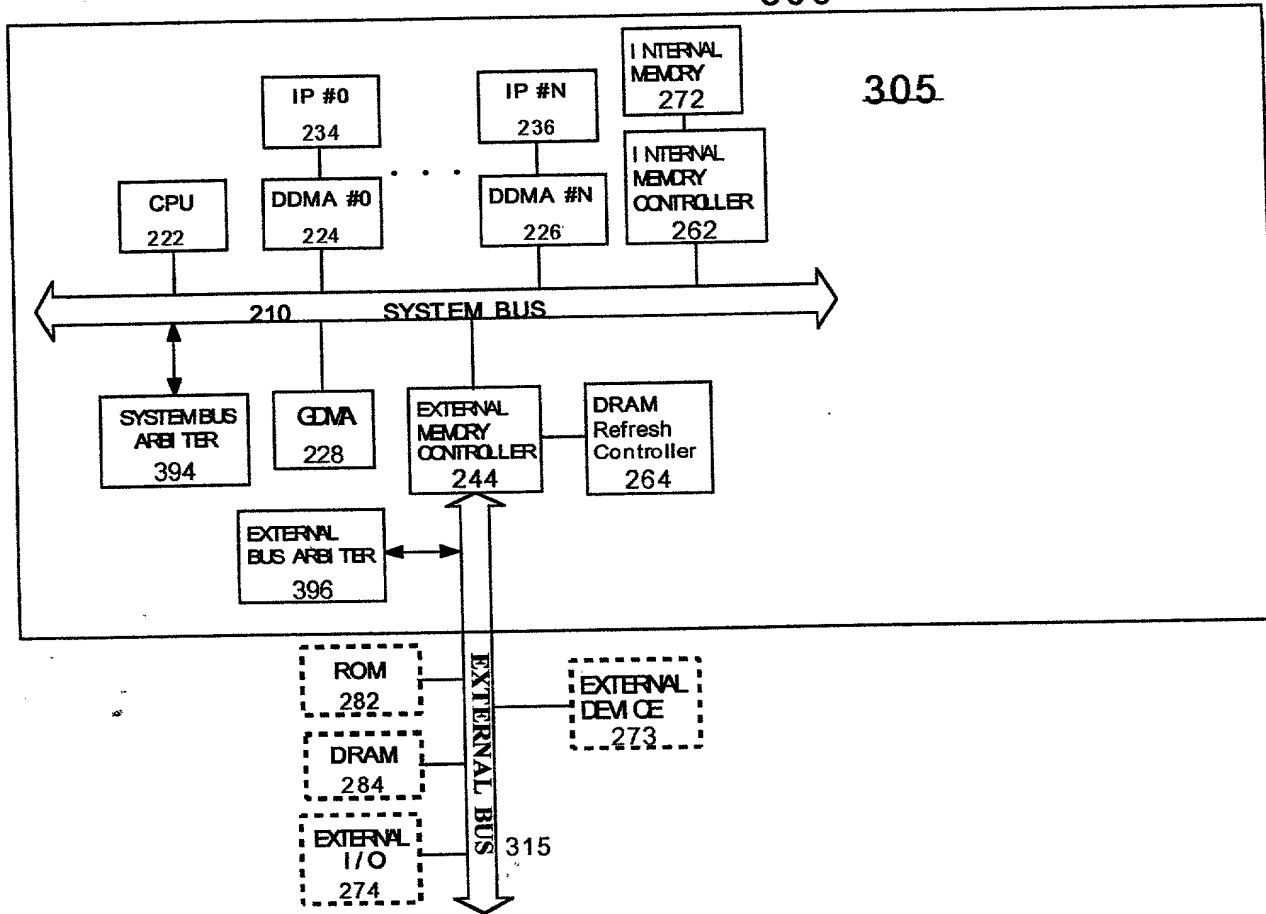


FIG.3B (PRIOR ART)

394

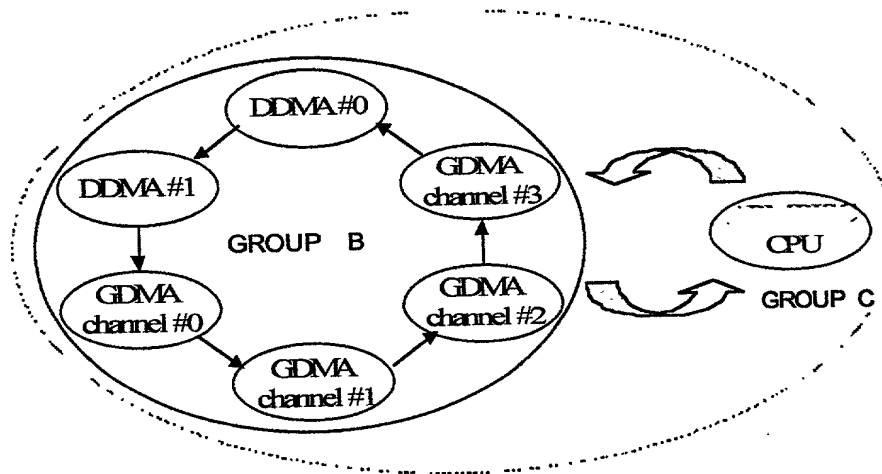


FIG.3C (PRIOR ART)

396

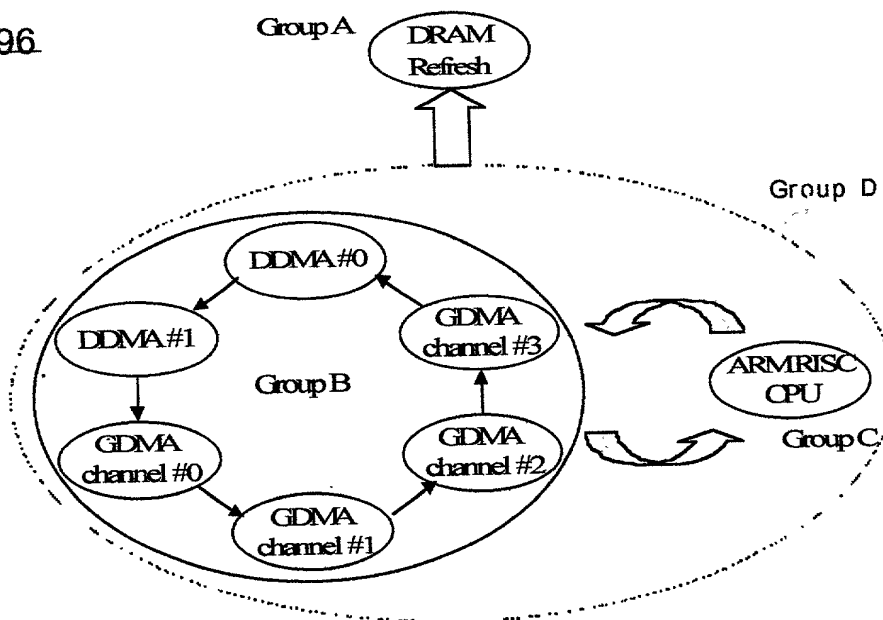


FIG.3D (PRIOR ART)

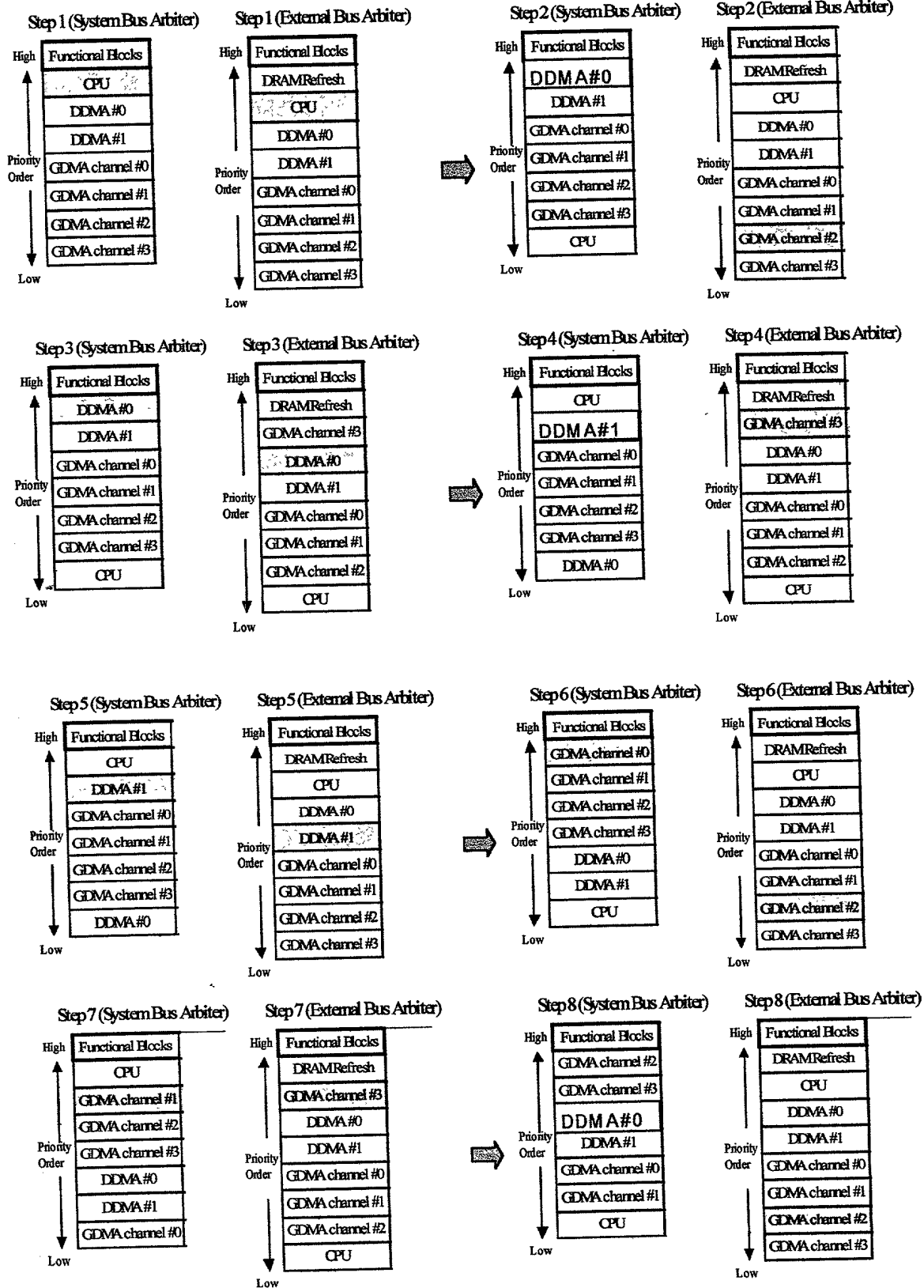


FIG.4

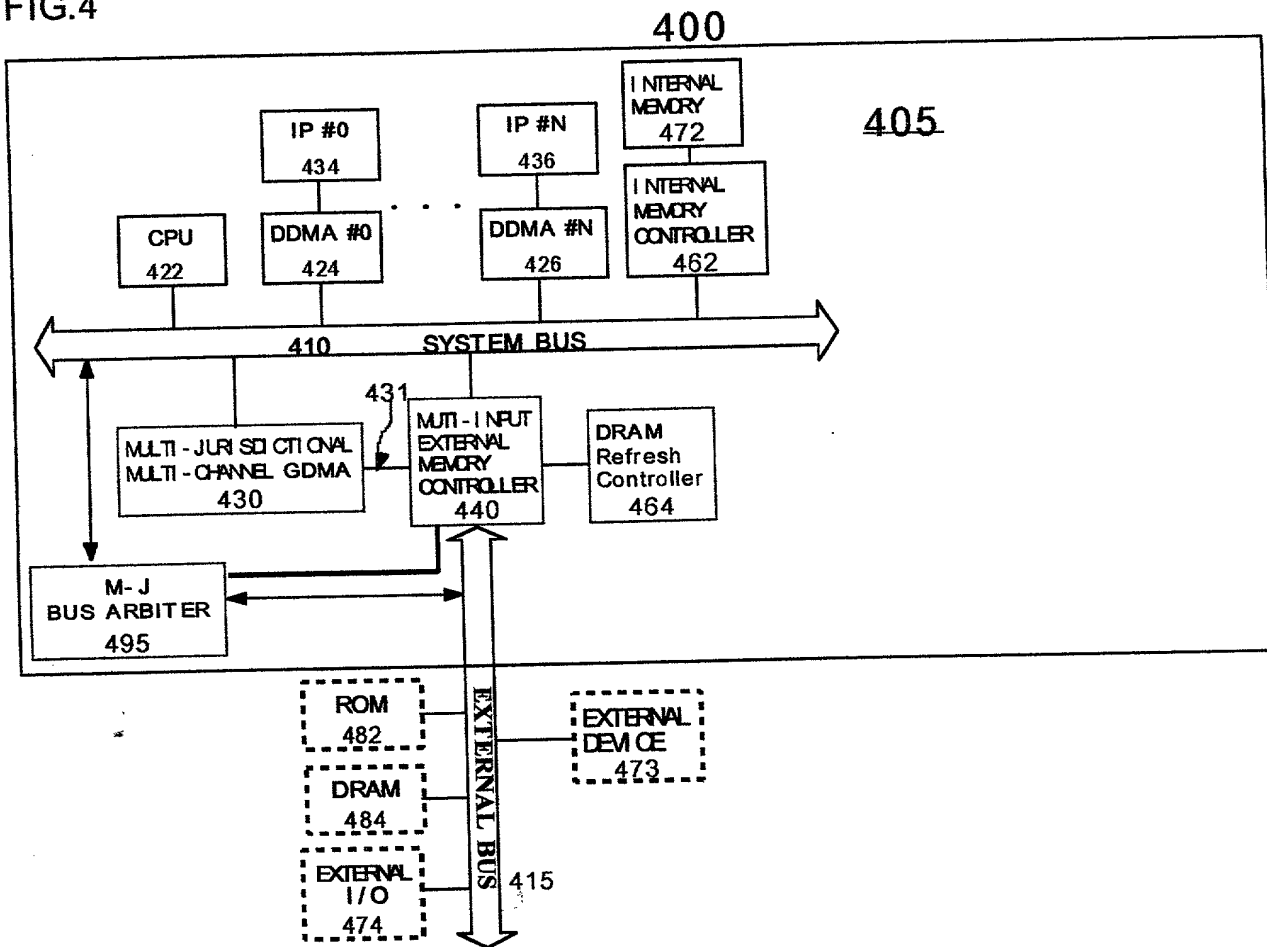


FIG.5

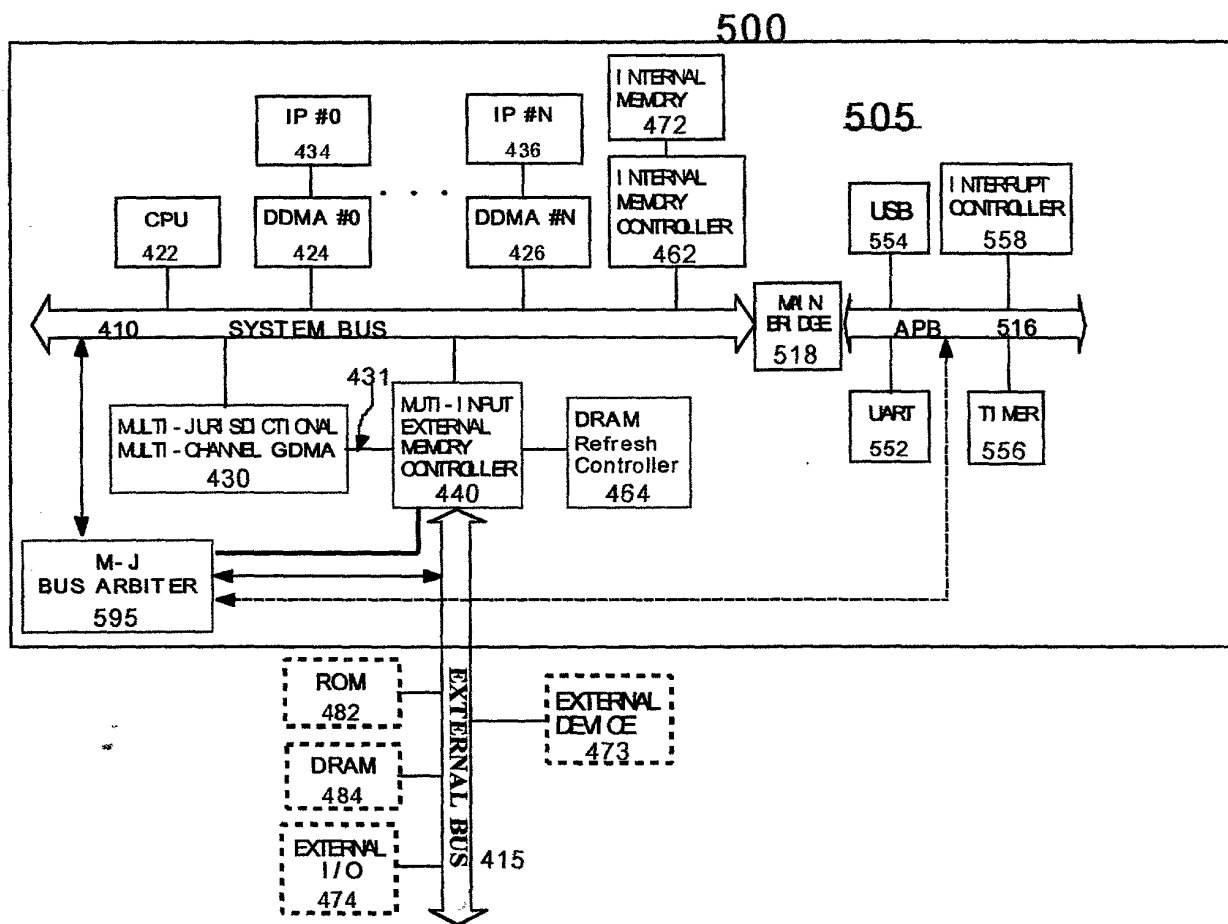
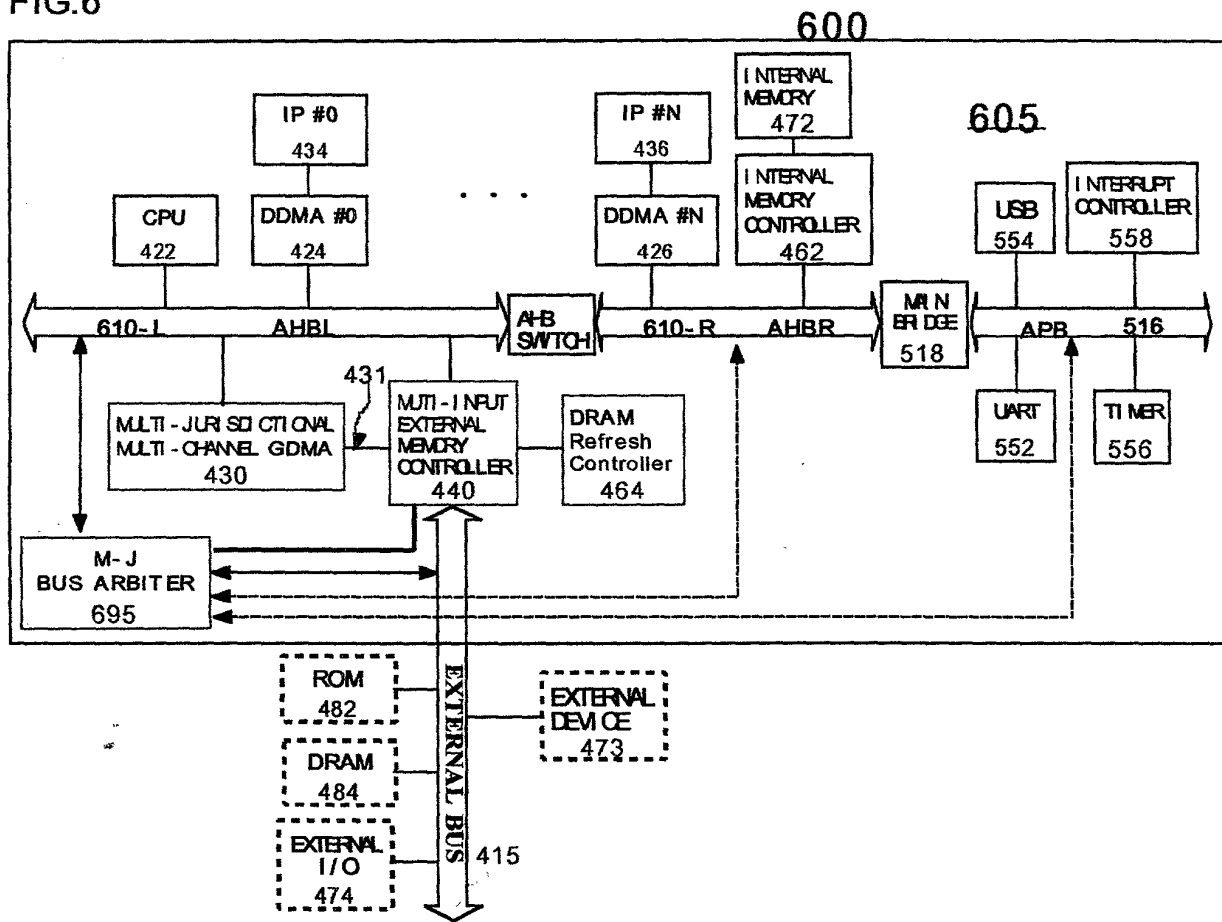


FIG.6



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FIG. 7

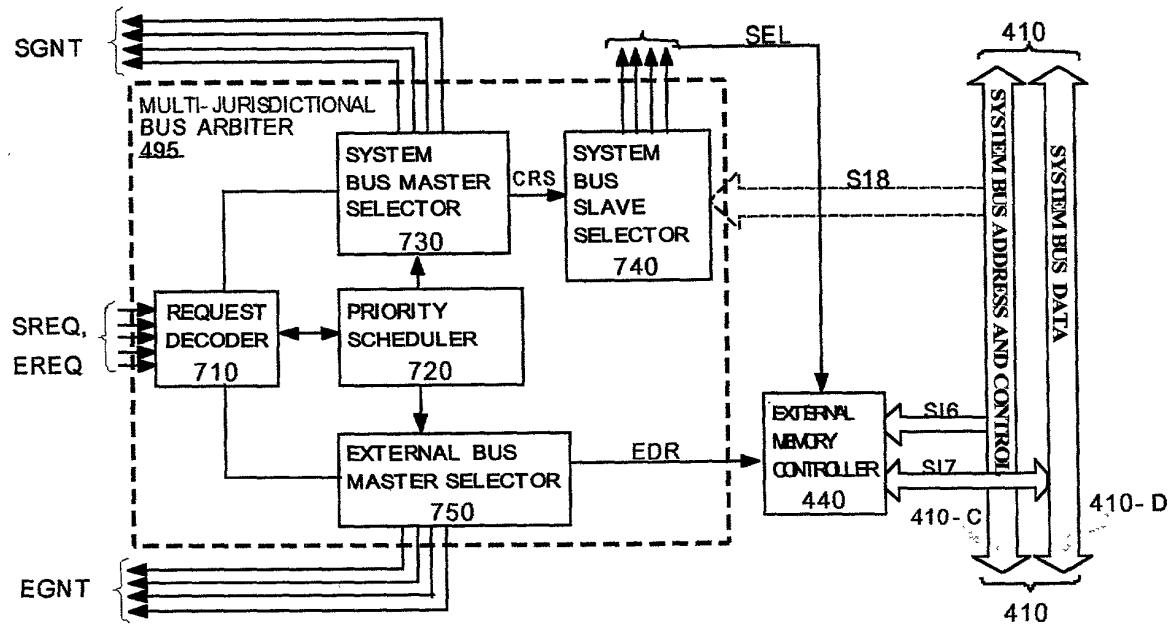


FIG.8

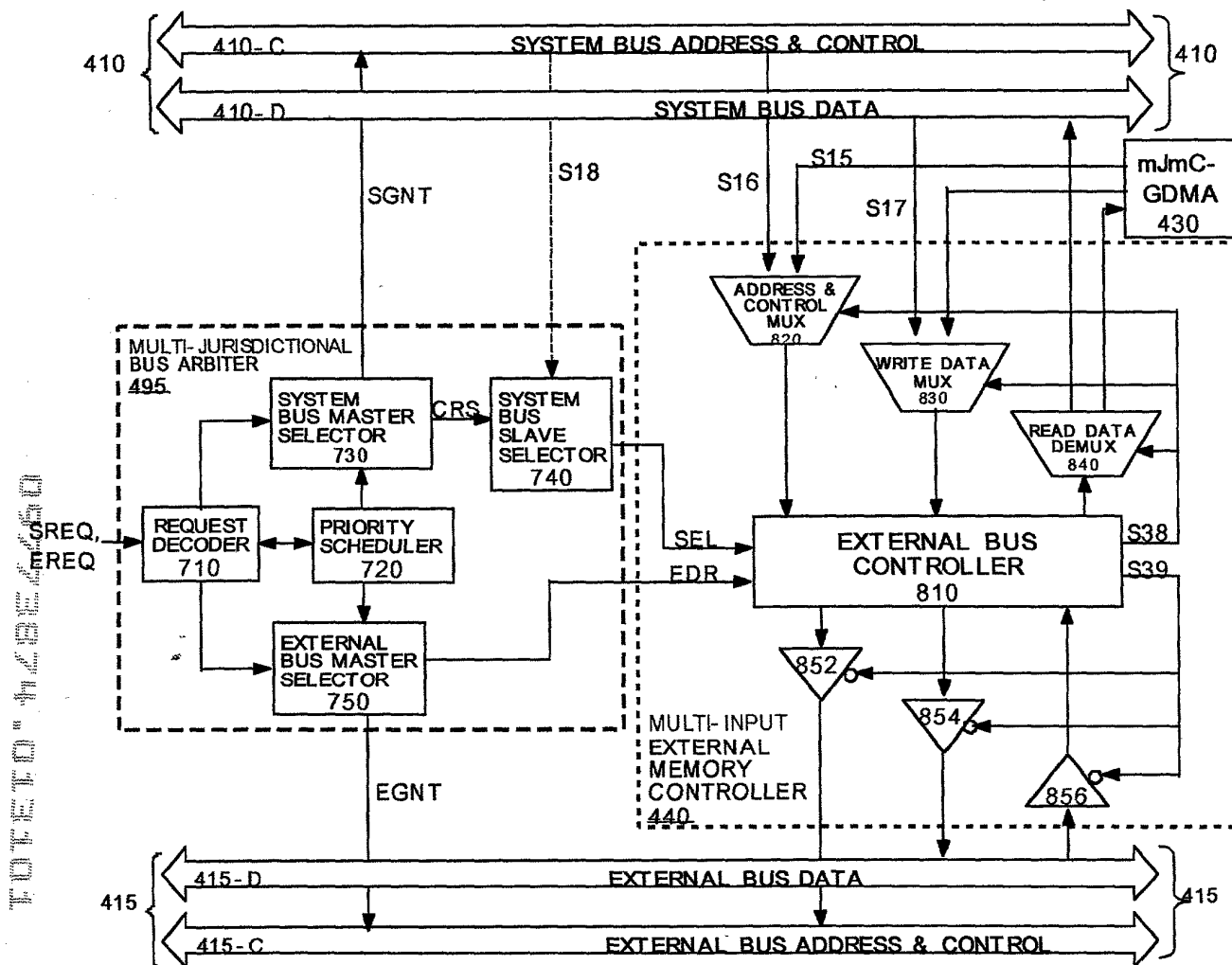


FIG.9

		External bus master	System bus master	
	No request REQ[1:0] = 2' b00	External bus only REQ[1:0] = 2' b10	System bus only REQ[1:0] = 2' b01	Both buses REQ[1:0] = 2' b11
DRAM refresh controller	O	O	X	X
CPU	O	X	O	O
DDMA block	O	X	O	O
GDMA channel	O	O	O	O
External device	O	O	X	X

FIG.11

Classification of set	Element
Set of functional blocks making a system bus request (system bus master, S)	CPU, DDMA block, and GDMA block
Set of functional blocks making an external bus request (E)	DRAM refresh controller, CPU, DDMA block, GDMA channel, and external device
Set of functional blocks making only a system bus request (SO)	CPU
Set of functional blocks making only an external bus request (EO)	DRAM refresh controller, GDMA channel, and external device
Set of functional blocks making a request for both system bus and external bus (ES)	CPU, DDMA block, and GDMA channel
Set of functional blocks making requests for a system bus or an external bus (A)	DRAM refresh controller, CPU, DDMA block, GDMA channel, and external device

FIG.10

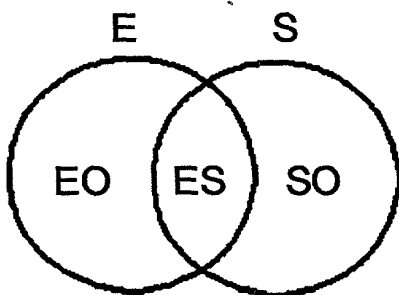


FIG.12

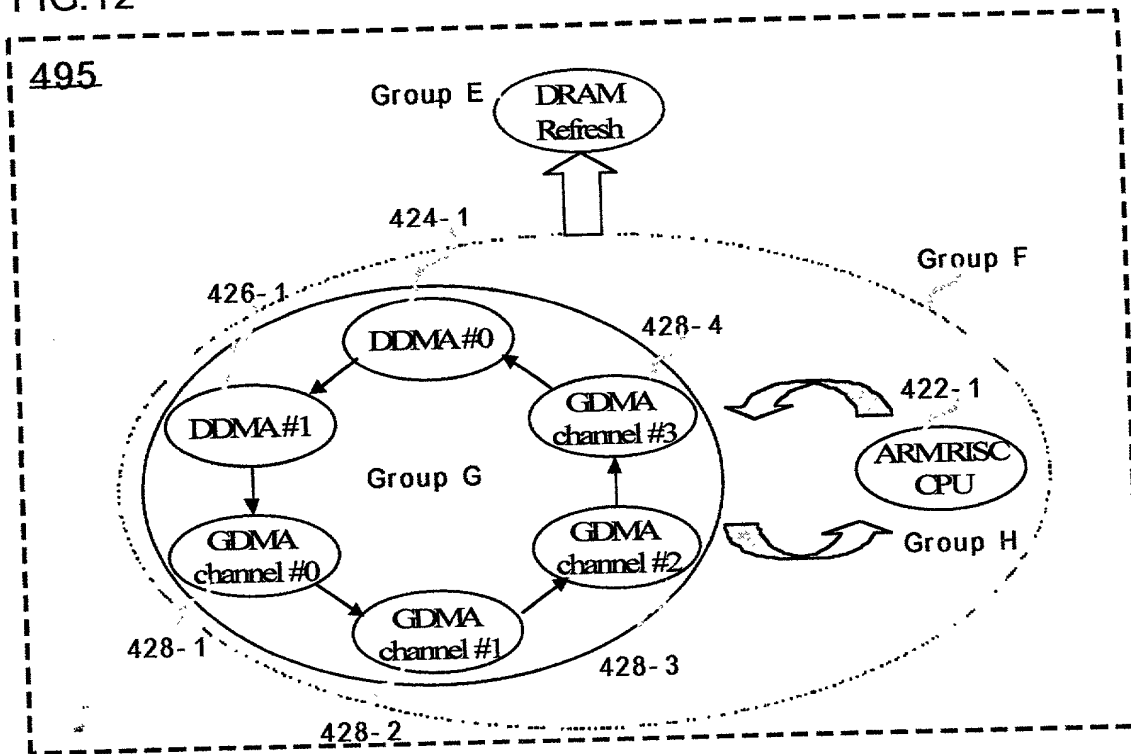


FIG.13

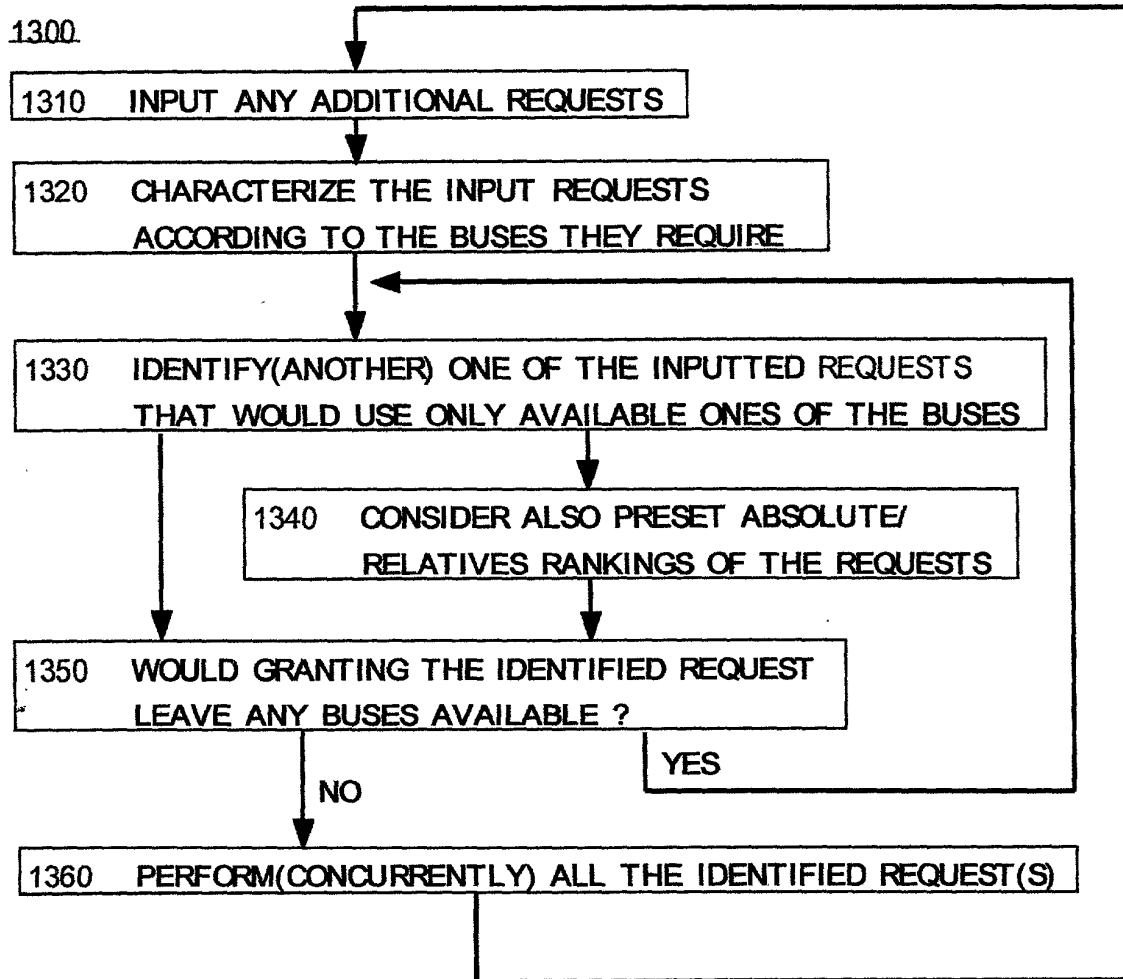


FIG.14

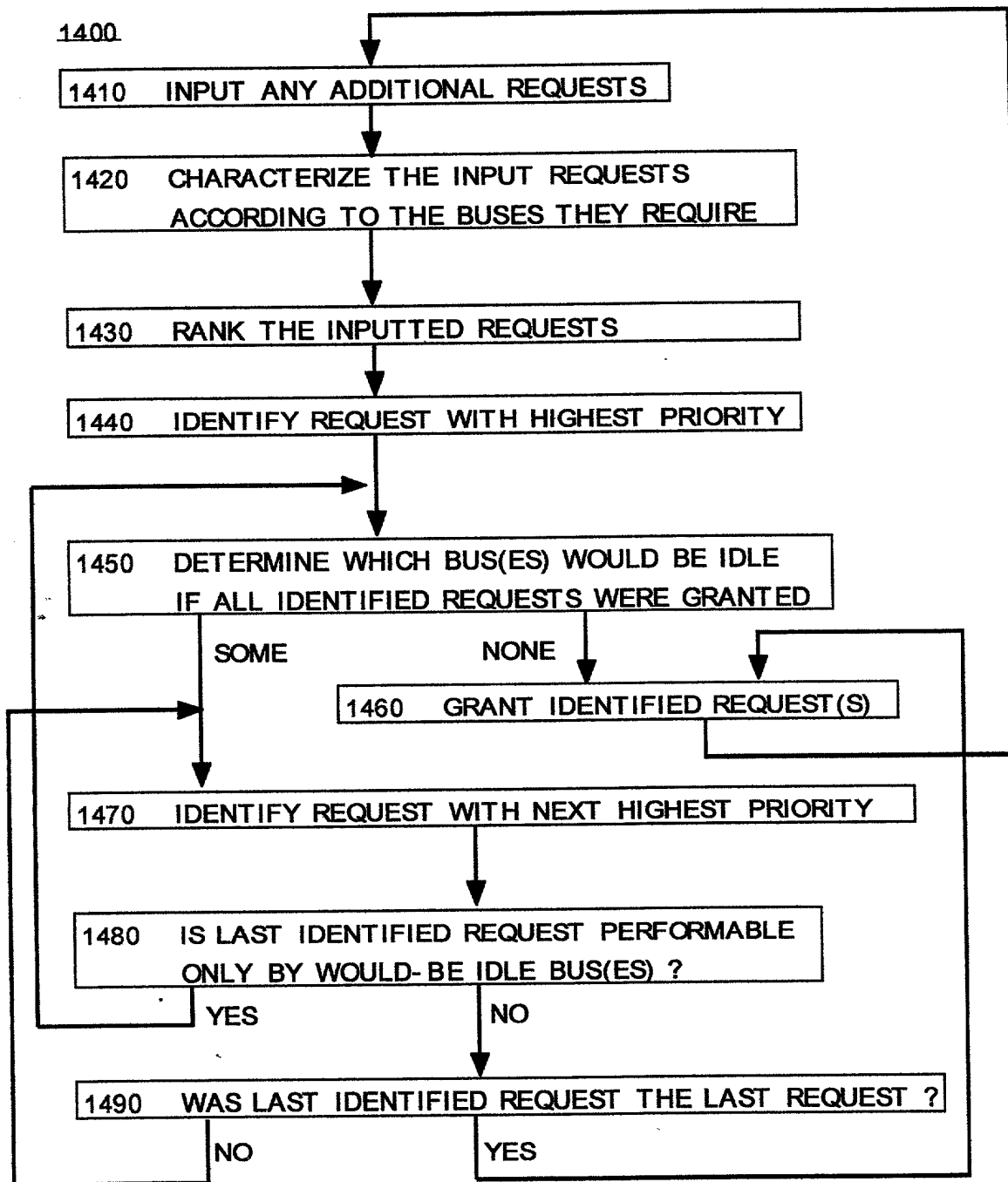


FIG.15

1500

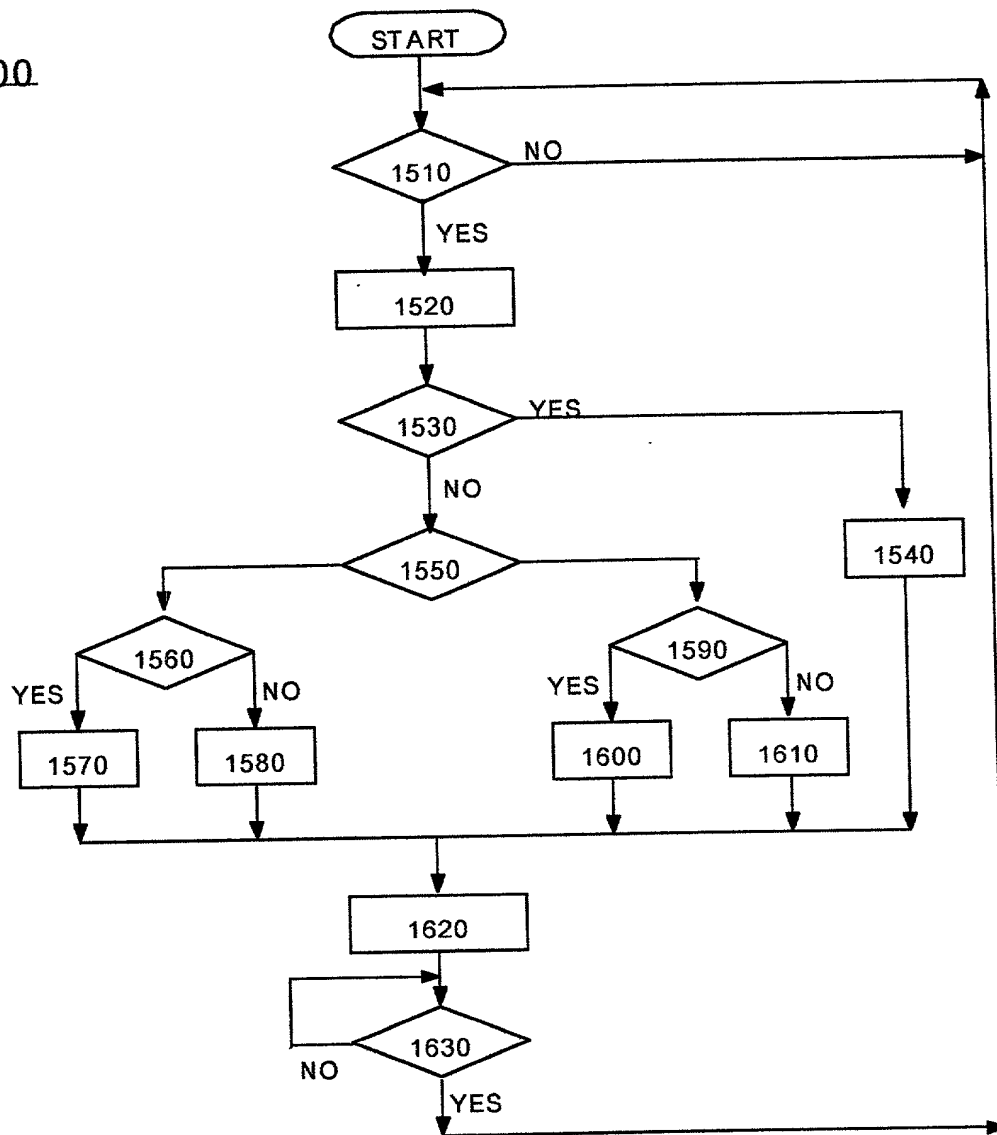


FIG.16

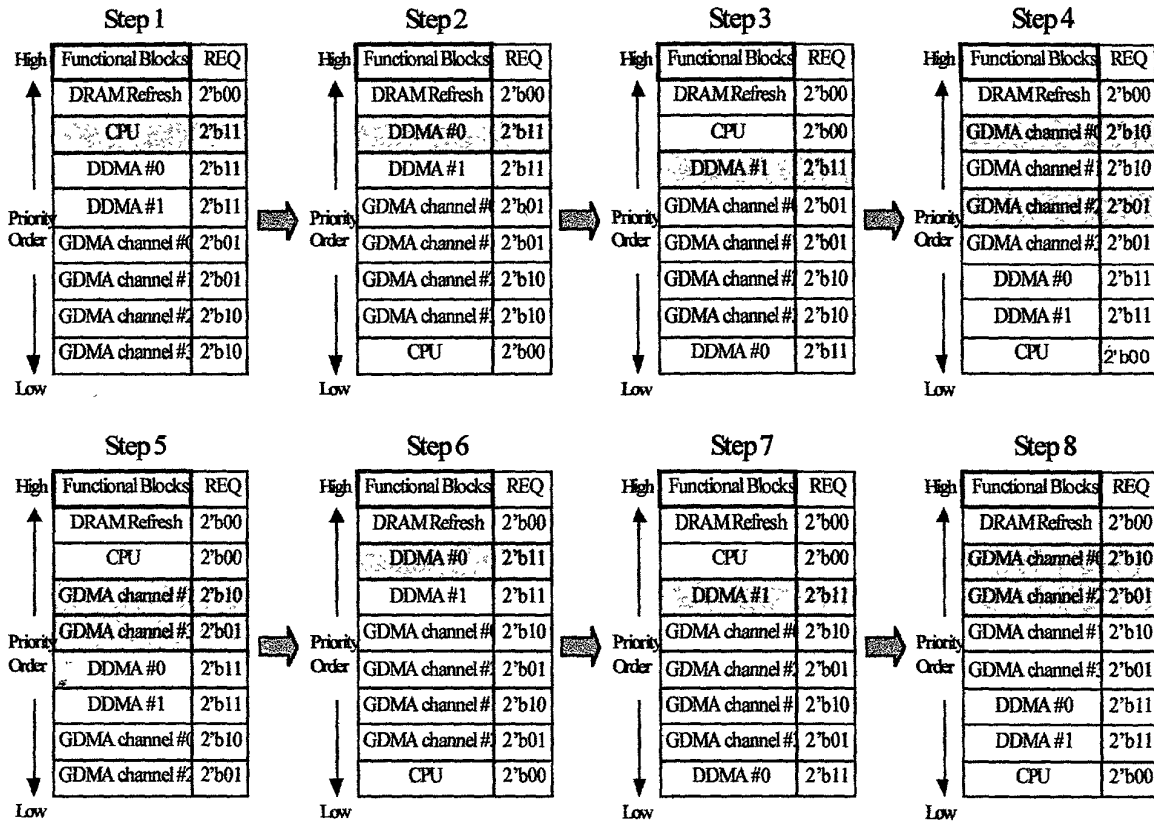


FIG.17

Item	Probability that element having bus ownership performs operation			Bus utilization
	Element of set EO	Element of set ES	Element of set SO	
Exclusive bus arbitration	$\frac{1}{n(A)}$	$\frac{1}{n(A)}$	$\frac{1}{n(A)}$	$\frac{n(EO) + 2n(EO) + n(SO)}{2n(A)}$
Hierarchical bus arbitration	$\frac{n(ES) + 2n(SO)}{2n(S)n(EO)}$	$\frac{1}{2n(S)}$	$\frac{1}{n(S)}$	$\frac{4n(SO) + 3n(ES)}{4n(S)}$
Present invention	$\frac{n(EO) + n(SO)}{n(A)n(EO)}$	$\frac{1}{n(A)}$	$\frac{n(EO) + n(SO)}{n(A)n(SO)}$	1